

Yield and seed quality of mungbean (*Vigna radiata* L. Wilczek) in response to foliar spray of nutrients and growth regulators

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ABSTRACT

The present study was undertaken with the objective to find out the response of mungbean varieties to foliar spray of nutrients and growth regulators on yield and seed quality. The treatments consisted of three varieties viz; Pant Mung 2 (small seeded), Pant Mung 4 (medium seeded) and Pant Mung 5 (bold seeded) and six foliar sprays (urea 2%, NPK 2%, DAP 2%, salicylic acid 100 ppm and indole butyric acid 100 ppm and control). Foliar spray of nutrients and growth regulators was done twice 40 and 55 days after sowing. The experiment was laid out in a Randomized Block Design with three replications. Results revealed that bold seeded variety Pant Mung 5 recorded the highest seed yield and yield attributes, whereas the highest biological yield was noticed in small seeded variety Pant Mung 2 with lowest harvest index. Seed quality parameters were also highest in bold seeded variety Pant Mung 5. In case of foliar sprays of nutrients and growth regulators, 2% DAP produced significantly higher yield which was *at par* with 2% urea and 100 ppm salicylic acid. Thousand seed weight was also significantly highest in foliar spray of 2% DAP followed by 2% urea. Protein content in seeds increased significantly in foliar spray with 2% urea whereas, other seed quality parameters such as germination percentage and vigour index were significantly highest in crop following foliar spray of 100 ppm salicylic acid. The data showed significant effect of interaction of varieties and foliar spray of nutrients and growth regulator on grain weight per plant and protease enzyme activity.

Key words: Foliar spray, Growth regulator, Mungbean, Nutrient, Yield, Seed quality

Mungbean (*Vigna radiata* L. Wilczek), is an important pulse crop and serves as a major source of dietary protein. In India, mungbean ranks third after chickpea and pigeonpea. It grows in both Kharif and summer, raining season but maximum area is occupied in *kharif* season. Mungbean covers an area of 4.3 mha with a production of 2.07 mt and an average productivity of 481 kg/ha (Anonymous 2017). Quality of planting material plays an important role as yield per unit area of a crop mainly depends on the initial quality of the seeds, agronomic practices and use of modern inputs. Quality seed accounts for 25-30% of the total yield increase. (National Food Security Mission 2010). Seed quality is a complex phenomenon, influenced by genetic, agronomic and environmental factors. Among the agronomic factors selection of the variety, its establishment, growth and development are to be taken

care of through management practices. Yield potential of varieties depend on many physiological processes and growth habits as branching, pod length and seed size etc. The effect of seed size in relation to seed quality characters are warranted as amount of food reserved in seed which is the basic requirement for its future expression in terms of emergence and final crop establishment. As it is mentioned that higher potential of bold seeded var., might be done to inhale capital. The higher potential of bold seeded variety might be due to the initial capital and more activity of redox enzymes which help in quick breakdown of complex food into simple soluble sugars and thereby improve germination process (Anuradha *et al.* 2009).

The improved genetic materials are highly responsive to nutrients. An adequate and timely application of nutrients helps in healthy growth, higher yield and good seed quality. Application of nutrients through foliar spray along with soil application has several advantages in supplementing the nutrition requirement of crops. Among all the nutrients, role of nitrogen is important because it is the building substances from which the protoplasm of every cell is made. Similarly, phosphorus helps in root development, crop maturation, formation and translocation of carbohydrates, and also resists the incidence of pathogen to diseases. The fertilizer with different ratio of N, P and K are highly water soluble and amenable for foliar nutrition. Pulses itself considered as a nitrogen rich source because of high nitrogen fixation capacity but their demand for nitrogen is more critical at flowering and seed development stage. Therefore, availability of nitrogen especially during reproductive stage is an important factor influencing the yield and quality of seed.

In the pulses, flowers drop is a major problem as it determines the yield and yield attributing characters. So, retention of flower by the plants may help to improve the yield. It is possible through foliar spray of growth regulators as well as macronutrients during flower initiation and pod development stages with soil application of macronutrients (Chaurasia *et al.* 2005). Foliar spray has proved to be an important method of fertilizer application with the specific aim of reducing nutrient with a very low consumption of energy and the uptake is independent on environmental factor such as moisture. Foliar spray of growth regulators also has positive effect on plant metabolism and thus promotes yield. Plant growth regulators are well known to improve physiological and

biochemical processes during biotic and abiotic stresses, which directly or indirectly affect the crop yield. They enhance the source sink relationship and stimulate the translocation of photo assimilates, thereby increase the productivity. Foliar spray of plant growth regulators stimulates synchronized bloom, reduces flower drop, improves seed setting and ultimately increase the yield (Ramesh *et al.* 2001). Salicylic acid is a secondary metabolite acting as analogue to growth regulating substances and helps in protein syntheses. Also, IBA promotes growth and consequently increases translocation and accumulation of building metabolites to seeds. There is relatively little information available in mungbean about foliar spray in combination to soil application of nutrients on quality and quantity of seed produced by newly released genotypes.

MATERIALS AND METHODS

The seed material of three varieties i.e Pant Mung 2 (small seeded), Pant Mung 4 (medium seeded) and Pant Mung 5 (bold seeded) of mungbean were obtained from Crop Resesrch Centre of GB Pant University of Agriculture and Technology Pantnagar. The varieties were selected on their thousand seed weight. The total treatments consisted of three varieties and six foliar sprays of nutrients and growth regulators i.e. urea 2%, NPK 2%, DAP 2%, salicylic acid 100 ppm and indole butyric acid 100 ppm and control). The crop was planted in 1st fortnight of August, 2017 in *kharif* season with a spacing of 30cm x 10cm for all the treatments. The fertilizer was applied @ 20 kg N, 40 Phosphorus and 20 kg potash through NPK mixture (12:32:16) and rest of the nitrogen by urea as basal at the time of sowing. Spraying of nutrients and growth regulators was done uniformly in each plot at 40 and 55 days after sowing. For recording yield contributing parameters, total five plants were randomly selected and tagged from the marked 2 meter row length after foliar spray of nutrients and growth regulators. Number of pods per plant was calculated by total number of pods from the five tagged plants from individual per plot and divided by five to obtain number of pods per plant. From five tagged plants, ten pods were randomly taken and grains were separated from the pods. Total number of grains from ten pods were counted and divided by ten to calculate, the value number of grains per pod. Selected plants were threshed separately and pods were collected. The threshed grains were separated, to measure the total grain weight. The grain weight per plant was calculated by dividing the total grain weight with five. After harvesting and threshing net plot, the seeds were weighed to get yield per plot and expressed in kilogram per hectare. Total biological yield per hectare was calculated by multiplying, the obtained biological yield from the net plot area with a suitable conversion factor. Harvest index was calculated by dividing the total grain yield with biological yield from the net plot as per the

following formula given by Donald (1962). After threshing and winnowing, random seed samples of 100 seeds were taken from net harvested plot of each treatment in three replications. Their weight was weighed and multiplied with ten to calculate 1000 seed weight in grams. For laboratory studies, the seeds from each plot were considered as a separated seed lot and sampling for laboratory observations was done by hand method to obtain uniform and representative sample for following laboratory observations.

Germination percentage: For conducting germination test, three replicates of 100 seeds were placed in between the rolled tower paper and kept in a germinator maintained at 25±2 0C and 95±2 % RH. The seedlings were evaluated after eight days according to the standard procedure for germination as described in International Rules for Seed Testing (ISTA 2015) and expressed in percentage. During germination test, daily observations were recorded to count number of seeds germinated per day. Speed of Germination *i.e.* Germination Index (GI) was determined by the following formula as suggested by Manguire (1962).

$$\text{Germination Index} = \sum \frac{n}{d_i}$$

Where,

n = number of seeds germinated on i^{th} day.

d_i = i^{th} days after incubation

Seedling vigour index: Seedling vigour index was computed by multiplying seed germination into Seedling length (cm/seedling) as suggested by Abdul-Baki and Anderson (1973). To work out protein content of seeds, nitrogen content of seed was estimated by Micro Kjeldahl method and then it was multiplied by cofactor *i.e.* 6.25 (A.O.A.C. 1960). The protease activity was calculated by the method suggested by Majumdar & Majumdar 2003 and expressed as mg of maltose per gram of seed.

RESULTS AND DISCUSSION

Yield and yield attributes: Field appraisal of foliar spray of nutrients and growth regulators was made in terms of number of pods, number of grain per plant, grain weight per plant, yield and seed quality characteristics of three mungbean varieties (Table 1). The highest number of pods per plant (21.9) and number of grains per pod (10.9) was noticed with bold seeded variety Pant Mung 5 which was significantly superior to rest of the two varieties. Lowest number of pods and number of grains per pod was noticed with medium seeded variety Pant Mung 4 (11.7) and was statistically inferior to other two varieties of mungbean. Varietal differences were noticed for yield attributing characters among the varieties. Improved yield attributes in bold seeded variety as noted here (Table 1) might be due to earlier emergence and vigorous seedling giving more energetic start which influence in early pod initiation and

Table 1. Numbers of pods per plant, number of grains per plant, grain weight per plant, vigour index of mungbean in response to different varieties and foliar spray of nutrients and growth regulators

Treatment	No of pods /plant	No of grains per pod	Grain wt /plant (g)	Seed yield (kg/ha)	Biological yield (kg/ha)	Harvest Index (%)
Variety						
Pant Mung 2	18.8	9.2	4.89	2474	786	31.7
Pant Mung 4	11.7	7.3	3.79	2398	767	32.0
Pant Mung 5	21.9	11.0	11.40	2369	839	35.4
SEm±	0.2	0.1	0.13	24	19	0.6
C.D.(p=0.05)	0.7	0.4	0.37	69	54	1.8
Foliar spray						
Control	16.3	8.2	5.42	2115	697	33.0
Urea 2%	18.1	9.5	7.21	2527	826	32.6
NPK 2% (12:32:16)	17.1	8.9	6.16	2394	795	33.2
DAP 2%	19.1	10.5	8.66	2608	879	32.7
SA * 100 ppm	17.7	9.3	6.87	2493	821	32.9
IBA **100 ppm	16.5	8.3	5.80	2344	765	32.7
SEm±	0.3	0.2	0.18	34	27	0.9
C.D.(p=0.05)	0.9	0.5	0.53	97	76	NS

*Salicylic acid; **Indole butyric acid; Germination test was performed after 2 month after harvesting

resulted in maximum number of filled pods per plant, grains per pod and grain weight per plant. Sarker *et al.* 2004 observed the variation in the seed yield among mungbean varieties, which was due to variation in number of effective pods per plant. The results are in agreement with the results of Vijaylaxmi and Bhattacharya 2007. Also, Gontia and Awasthi 1999 found that bold seeded varieties are superior over small seeded as it has maximum pod length which ultimately influenced number of grains per pod.

Foliar spray of nutrients and growth regulators remarkably increased yield attributes of mungbean. Foliar spray of 2% DAP resulted in highest number of pods per plant (19.10) and number of grains per pod (10.50) which were statistically superior to other treatments including control treatment. Control treatment produced lowest number of pods per plant (16.30) which was *at par* with 100 ppm indole butyric acid (16.50). Foliar treatment with 2% urea and 100 ppm salicylic acid recorded 9.5 and 9.3 grains per pod respectively being *at par* registered significantly number of grains per pod than 2% foliar spray of NPK (8.90). Whereas, 2% NPK (8.90) was *at par* with 100 ppm indole butyric acid (8.30). The lowest number of grains were obtained in control treatment (8.20) which was *at par* with 100 ppm indole butyric acid (8.30).

The result of the present study of interaction of varieties and foliar spray of nutrients and growth regulator also significantly influenced on grain weight per plant (Fig. 1). Bold seeded variety Pant Mung 5 recorded the higher grain weight per plant in comparison to small seeded variety Pant Mung 2 and medium seeded variety Pant Mung 4 in all the treatments. The interaction among bold seeded variety Pant Mung 5 and foliar application of 2% DAP obtained highest grain weight (15.33g) over other treatments. Biological yield is the sum total of various growth parameter like plant height, trifoliolate leaves, dry matter accumulation etc. The cumulative effect of these

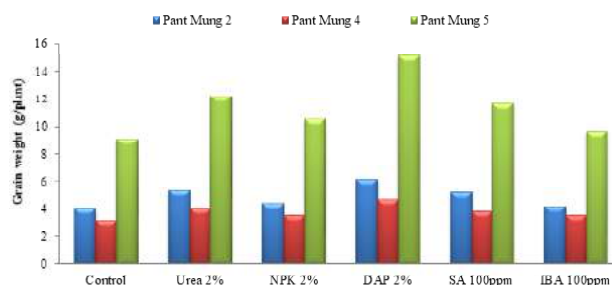


Fig 1. Grain weight per plant of mungbean as influenced by variety×foliar spray of nutrients and growth regulators

characters ultimately results in higher biological yield. In the present investigation, application of 2% DAP influenced the growth and development of the crop in terms of biological yield (Table 1). The findings of Mallika vananaga mudi *et al.* 2004 also confirmed the results of present study. It has been observed that harvest index increased with increase in seed size. Higher harvest index in bold seeded variety might be due to more partitioning of dry matter towards pods. Similar results were reported by Chittibabu 1992 in groundnut. Lomte *et al.* 2006 also reported that the harvest index varies with varieties because of variable yield potential in variable environment. The foliar spray treatments showed non-significant differences. The highest values ranged from 33.7% to 32.6%.

Yield is a function of number of plants per unit area and yield per plant. The later is attributed to number of pods per plant, number of grains per pod and grain weight per plant. It was observed that foliar spray of 2% DAP and 2% urea improved the yield attributes because of complete utilization of additional foliar applied nitrogen and phosphorous by the plant and improved efficiency of nitrogen because nitrogen penetrates the cuticle of leaf or stomata and then enters the cell. Foliar application of DAP at flowering and pod initiation stage showed the highest yield attributes characters. It was significantly higher than

other treatments. The results revealed that foliar spray of 2% DAP increased number of pods per plant, number of grains per pod and grain weight per plant. This may be due to the quick absorption of nitrogen and phosphorus at pods during reproductive stage, when the demand of nutrients is at its peak. Also, foliar spraying at pod filling stage is more effective than during vegetative stage because nutrients applied at this stage were easily used for photosynthesis and further the assimilates were mobilized for grain filling and protein accumulation in grain. The significant results of foliar feeding of 2% DAP at flowering and pod filling stage with soil application to pulse crop had also been reported by Maheshwari and Karthik 2017. Kukubun 2011 reported that foliar spray improved the source and sink relationship and resulted in more number of pods per plant in soybean. These results are also in the conformity with those of Kumar *et al.* 2016, Kumar *et al.* 2013, Manasa 2013, Dandge *et al.* 2018.

Data obtained on seed yield are presented in Table 1 which indicated significant effect on both the factors varieties and foliar spray of nutrients and growth regulators. The highest seed yield was recorded with bold seeded variety Pant Mung 5 (839 kg/ha) which was *at par* with the seed yield obtained from small seeded variety Pant Mung 2 (786 kg/ha). The medium seeded variety Pant Mung 4 produced lowest seed yield (767 kg/ha) which was statistically *at par* with small seeded variety Pant Mung 2. Verma *et al.* 2005, Adebisi *et al.* 2013 also reported that bold seeded varieties resulted in maximum seed yield and found superior to small and medium seeded varieties. Among all the foliar spray, 2% DAP recorded maximum seed yield of 879 kg/ha followed by 2% urea spray (826 kg/ha) and 100 ppm salicylic acid (821 kg/ha) which were *at par* with each other. The lowest seed yield was obtained with control (697 kg/ha) which was *at par* with yield obtained from 100 ppm indole butyric acid (765 kg/ha). Beneficial effect of foliar spray of DAP on seed yield can be explained in the light of fact that foliar application increases number of pods per plant, number of grains per pod and grain weight per plant. Probably because of high photosynthetic caused by better radiant energy utilization as indicated by increase in grain weight per plant with foliar application of 2% DAP at flowering and pod initiation stage. High amount of assimilates available for seed development with foliar dose of nutrient might have contributed to high yield. Additional application of nutrients as foliar spray significantly increased grains per pod, grain weight per plant ultimately increased the seed yield it may be due to the fact that immediate and adequate availability of nutrients and less nutrient losses. The results of present investigation are in conformity with those of Maheshwari and Karthik 2017, Dandge *et al.* 2018, Yadav and Choudhary 2011, Malay and Bhowmik 2006. Biological yield was highest in small seeded variety Pant Mung 2 which was significantly superior to other two varieties. Among the foliar treatments, 2% DAP

showed highest biological yield which was significantly superior to the rest of the treatments except 2% urea spray. The lowest biological yield was recorded with control treatment. Harvest index was significantly influenced by varieties. The highest value was recorded with bold seeded variety Pant Mung 5 which was significantly superior to other two varieties whereas, foliar application of nutrients and growth regulators did not show any significant variation on harvest index.

Seed quality: Statically analysis of data indicated that different varieties and foliar spray of nutrient and growth regulators had significantly influence on seed quality of mungbean. The Bold seeds variety registered significantly higher seed weight than rest of the varieties. All the varieties differed significantly with each other. Thousand seed weight is an index of boldness of grains resulting from the transfer of photo synthetic from source to sink. Verma *et al.* 2005 reported that hundred seed weight was highest in large seeded seeds over small sized seeds in pigeonpea. Similar findings were also reported by Tawaha and Turk, 2004 in fieldpea.

Among foliar application treatments, the boldest seeds were found with spraying of 2% DAP (36.1g) which was significantly superior to the rest of the foliar treatments. It was followed by 2% urea spray (35.4g). Foliar spray of urea was significantly superior to 100 ppm salicylic (34.3g) acid and 2% NPK (34.1g) which was with each other. The smallest seed were recorded with control (32.6g) and was *at par* with 100 ppm indole butyric acid (32.7g). Foliar spray of nutrients decreased the interplant competition which resulted in bolder seeds. The results are in agreement with the study done by Manonmani and Srimathi 2009 on blackgram.

In the present study, germination percentage was affected by seed size. The effect of seed size in relation to seed quality characters are warranted as amount of food reserve in seed is the basic requirement for its future expression in terms of emergence and final crop establishment. The maximum germination percentage, seedling length and seedling vigour index was observed in bold seeded variety Pant Mung 5. The higher potential of bold seeded variety might be due to the initial capital and more amount of nutrients available for emergence as suggested by Anuradha *et al.* 2009. Gurbanov and Bertri, 1970 also stated that higher germination may be due to increased activity of redox enzyme in bold seeds which helps in quick breakdown of complex food into simple soluble sugars and also increase germination. Among the foliar spray, the highest seed germination was recorded with the application of 100 ppm salicylic acid (82.8%), which was *at par* with 2% urea (80.2%) (Table 2). The lowest was recorded with control (74.4%) which was statistically *at par* with 100 ppm indole butyric acid (75.3%), 2% NPK (76.8%) and 2% DAP (78.2%).

Table 2. Thousand seed weight, germination index, germination percentage, seedling length, seedling vigour index and protein content of mungbean in response to different varieties and foliar spray of nutrients and growth regulators

Treatment	Thousand seed weight (g)	Germination Index	Germination (%)	Seedling length (cm/seedling)	Seedling vigour index	Protein (%)
Variety						
Pant Mung 2	28.1	18.4	75.1	10.6	833	19.8
Pant Mung 4	35.4	17.3	76.6	13.6	986	20.7
Pant Mung 5	42.1	10.2	81.3	14.0	1113	22.5
SEm±	0.2	.04	0.8	0.2	28	.05
C.D.(p=0.05)	0.5	0.12	2.5	0.7	80	0.15
Foliar spray						
Control	32.6	12.3	74.4	9.3	679	19.7
Urea 2%	35.4	14.4	80.2	12.6	989	22.1
NPK 2% (12:32:16)	34.1	16.3	76.8	10.0	782	21.5
DAP 2%	36.1	13.1	78.2	12.7	955	20.7
SA* 100 ppm	34.3	17.0	8.8	16.4	1309	21.6
IBA **100 ppm	32.7	18.3	75.3	14.3	1146	20.3
SEm±	0.2	.06	1.5	0.4	38	0.07
C.D.(p=0.05)	0.7	0.17	4.4	1.1	110	0.21

*Salicylic acid; **Indole butyric acid; Germination test was performed after 2 month after harvesting

Maia *et al.* 2000 found that salicylic acid promoted germination percentage in soybean besides stimulating the length of the roots and increased green matter. Salicylic acid plays an important role to activate peroxidase enzyme which is required for biosyntheses of lignin and subarin that are involved in cell stress as these substances are of great importance for the protection of plants (Sukhabut dinova *et al.* 2004). Kumar and Sarlach, 2015 also reported that there was considerable change in the seed germination with the foliar application of salicylic acid. It was reported that spray of salicylic acid controlled the transmission of fungal pathogen and produced healthy and quality seeds. Seed vigour in terms of rapidity of germination was assessed by speed of germination i.e. germination index. In the present study the effect of seed size on germination index was found significant. The results showed that small seed size emerged earlier compared to medium and bold seeded variety (Table 2). The reason may be due to small seed absorbs water quickly as compared to bold seeded and the breakdown of stored food material occurs resulting in plumule and radical growth quickly. Yousif 2010 also reported that speed of germination is influenced by seed size in sorghum. The superiority of small seeds over large seeds may be attributed to its high speed of germination. Same results were reported by Sahoo *et al.* 1988 in groundnut.

Foliar spray of nutrients and growth regulators also significantly influenced germination index of mungbean. The highest germination index was recorded with the foliar treatment of 100 ppm indole butyric acid (18.3). Whereas, the lowest germination index was recorded 12.3 seedlings/day without any foliar spray in control treatment. Seedling vigour index was computed by multiplying germination percentage and seedling length (cm/ seedling). It was responded significantly by different varieties and foliar spray of nutrients and growth regulators. Data presented in Table 2 indicated that the effect of varieties on seedling

vigour index followed similar pattern to that described for germination percentage. The bold seeded variety Pant Mung 5 recorded highest value of seedling vigour index I and was significantly superior to other two varieties. It recorded 1113 value followed by medium seeded variety Pant Mung 4 (986) and small seeded Pant Mung 2 (833). All the variety differed significantly with each other. The superiority of bold seeded over small seeded on vigour components may be attributed to its higher germination percentage and seedling growth. The results obtained in the present study regarding seedling vigour parameters are in the agreement with the results reported by Singh, 1999.

Among the foliar spray, the maximum seedling vigour index was observed with foliar spray of growth regulator 100 ppm salicylic acid which differed significantly from rest of the foliar treatments. It was followed by 100 ppm indole butyric acid. It may be due application of salicylic acid which results in increased cell division within the apical meristem of seedling and enhanced root and shoot growth. These results are in line with Kumar and Sarlach, 2015 in cowpea. The lowest vigour index was recorded with control treatment (679) and was found *at par* with 2% NPK. Protein content (%). The seeds of three different mungbean varieties produced with foliar spray of nutrient and growth regulators were also analyzed for protein and protease enzyme activity. In the present study it has been observed that bold seeded variety recorded significantly higher protein content than medium and small seeded variety. Supporting evidence was reported by Anuradha *et al.* (2009). They showed that protein content increases with increase in seed size. In the present study, foliar application was done at flowering (40 days after flowering) and pod initiation stage (55days after flowering). The effect of foliar spray of nutrients and growth regulators with respect to protein content ranged from 19.7% to 22.1%. Protein content was significantly highest with foliar application of

2% urea (22.1%) because nitrogen is important part of protein (Table 2). The lowest protein per cent was observed in control (19.7%). Foliar spray of nitrogen in the form of urea increase nitrogen availability probably due to increase in nitrate reductase enzyme leading to synthesis of high amount of protein. Palta *et al.* 2005 also reported that foliar spray of urea increases the protein content in seed due to increase in nitrogen availability for seed-filling in chickpea.

The data showed significant effect of interaction of varieties and foliar spray of nutrients and growth regulator on protease activity (mg of tyrosine/g of seeds) in mungbean. Bold seeded variety Pant Mung 5 registered significantly highest protease activity in comparison to other two varieties. The interaction between bold seeded variety Pant Mung 5 and foliar application of 100 ppm salicylic acid (53.0mg of tyrosine/g of fresh seeds) being *at par* with 2% DAP (51.9 mg of tyrosine/g of fresh seeds) registered significantly higher protease activity than remaining treatments (Fig. 2). This may be due to combine effect of bold seeded variety and foliar spray of growth regulators; it responded well to the foliar spray of growth regulator salicylic acid and produced highly vigorous seeds. From the above findings it can be summarized foliar spray of 2%DAP or urea at flowering and pod filling stage is advisable as it is easily available and economically feasible. In the laboratory studies, foliar spray of 100 ppm salicylic acid is beneficial for improving seed quality components. Since, these findings are based on one year experiment, further study is required to reach a definite conclusion and recommendation.

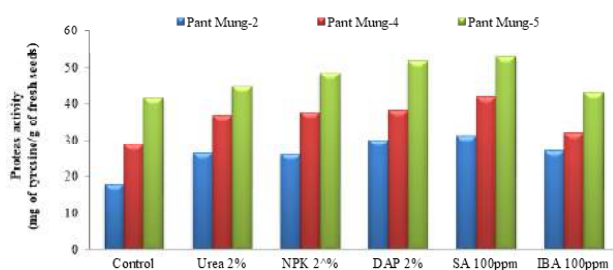


Fig 2. Protease enzyme activity of mungbean seed as influenced by variety and foliar spray of nutrients and growth regulators

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